Space Weather Technical Forecast

Issued on Thursday, 07 September 2023 at 13:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-flares (R1-R2 radio blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours with several C-class flares. There are currently six sunspot groups on the visible disc. The largest and most complex region remains AR3421. It is rather elongated and consists of a large amount of small spots, currently proliferating, and a rather large single one of opposite polarity. There was a hint of a delta spot for a time but it has now faded away. AR3423, in the east, continues to grow with the emergence of an intermediate spot with penumbra. It has also become slightly more complex magnetically. The other regions are relatively small and simple.

A CME was observed in the northeast during the morning (UTC) hours. There was no evident filament lift-off on available imagery nor any flare which could have been attributed to it and so, it is considered to originate from a far-sided region and is not thought to be Earth-directed.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured at L1 by ACE and DSCOVR, were perhaps indicative of a weak connection with a coronal hole high speed stream, most likely CH43/-. The solar wind speed was slightly elevated initially, between 400-430km/s, but slowly declined to ambient levels during the second half, now between 360-380km/s. Density was mostly at average or below average levels. The IMF was weak throughout at 6nT or below. The north-south component varied weakly between +/-4nT. The phi angle was mostly negative (towards the sun). Geomagnetic activity was Quiet, with only one Unsettled interval at the start of the period (06/1200-1500UTC).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background levels throughout. GOES16 high energy (greater than 2MeV) electron flux was predominantly at background levels but became moderate for a time, peaking at 831 pfu at 06/1440 UTC. The associated 24-hour fluence was below the Active threshold on a declining trend, with 1.16e7 integrated pfu observed at 07/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a chance of M-class flares throughout the period, mostly from AR3421 and AR3423.

Solar Wind / Geomagnetic Activity: There are two possible CMEs in the current forecast. The first is expected to be a glancing blow at worst late Day 1 or early Day 2 (07-08 Sep). A second CME is estimated to arrive late on Day 3 (09 Sep). This was extremely difficult to analyse due to the background of other CMEs, which reduces confidence in this forecast. The high speed stream (HSS) from CH42/+ is now considered unlikely to reach Earth. From late Day 1, but more likely Day 2 (08 Sep) a weak HSS from CH43/- may provide some slight enhancement to solar wind speeds. This may be followed by a further weak HSS from CH45/- on Days 3 into 4 (09-10 Sep).

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Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a risk of Active intervals with any HSS or CME influence. There is also a slight chance of isolated G1/Minor Storm intervals, this is most likely later Day 3 into Day 4 in association with the second CME.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at background levels, with a very slight chance of an enhancement should any larger flares occur from AR3421 and AR3423, especially later in the period.

High energy (greater than 2 MeV) electron flux carries high uncertainty, however it is thought most likely that fluence will remain below the Active (1e8 integrated pfu) threshold throughout, with just a slight chance of reaching this level mainly later in the period.

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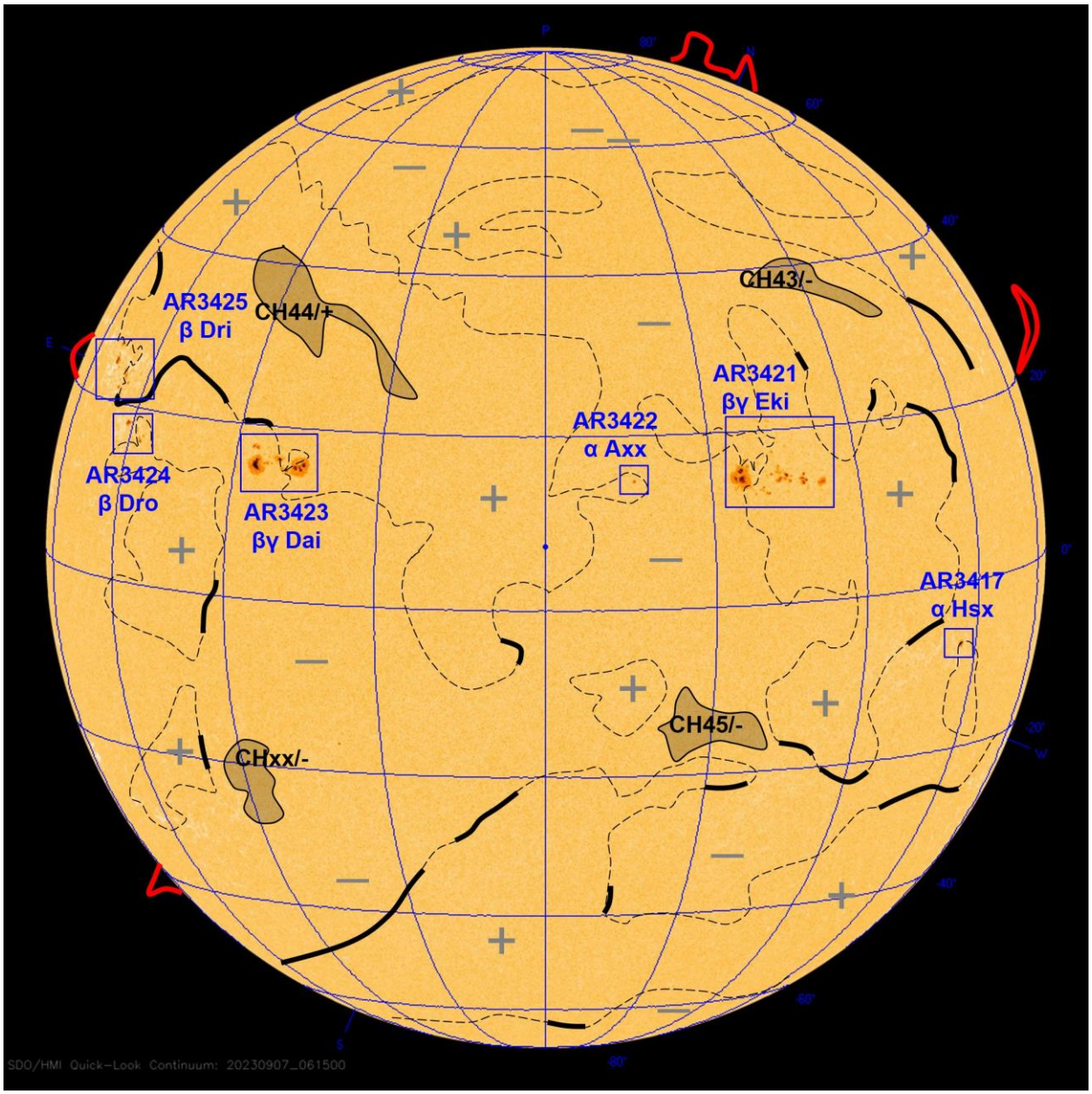
Figure 1. Solar Analysis Valid 07/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Although there have been a number of recent large CMEs, there are only a couple that are currently modelled to have any Earth-directed components. One that may produce a weak enhancement is the 04/1330UTC south-eastern quadrant filament eruption. This is expected to be a glancing blow at worst with the bulk of the ejecta expected to pass behind the Earth late Day 1 or early Day 2 (07-08 Sep). A second CME in association with a C-flare from south-centre disc on 05/2220 UTC has been analysed as fairly slow but with some Earth-directed component. The arrival time is estimated to be late on Day 3 (09 Sep) with a chance for some enhancement of geomagnetic activity. However, this was extremely difficult to analyse due to the background of other CMEs, which reduces confidence in this forecast.

Earth is possibly under the weak influence of the HSS originating from CH43, with solar wind speeds expected to fluctuate between ambient and slightly elevated levels (370-430km/s) over the next 24 hours (leading into Day 2). This may be followed by a further weak HSS connection from CH45/- on Days 3 into 4 (09-10 Sep).

In summary, in the absence of any further Earth-directed CMEs, geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a risk of Active intervals with any HSS or CME influence. There is also a slight chance of isolated G1/Minor Storm intervals, this is most likely later Day 3 into Day 4 in association with the second CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1706	Partial	Plage	SE	980 km/s	Early 08 Sep	Glancing blow possible, more likely to miss.
06/0610	Partial	Plage	S-Centre disc	440 km/s	Late 09 Sep	Limited impact expected.

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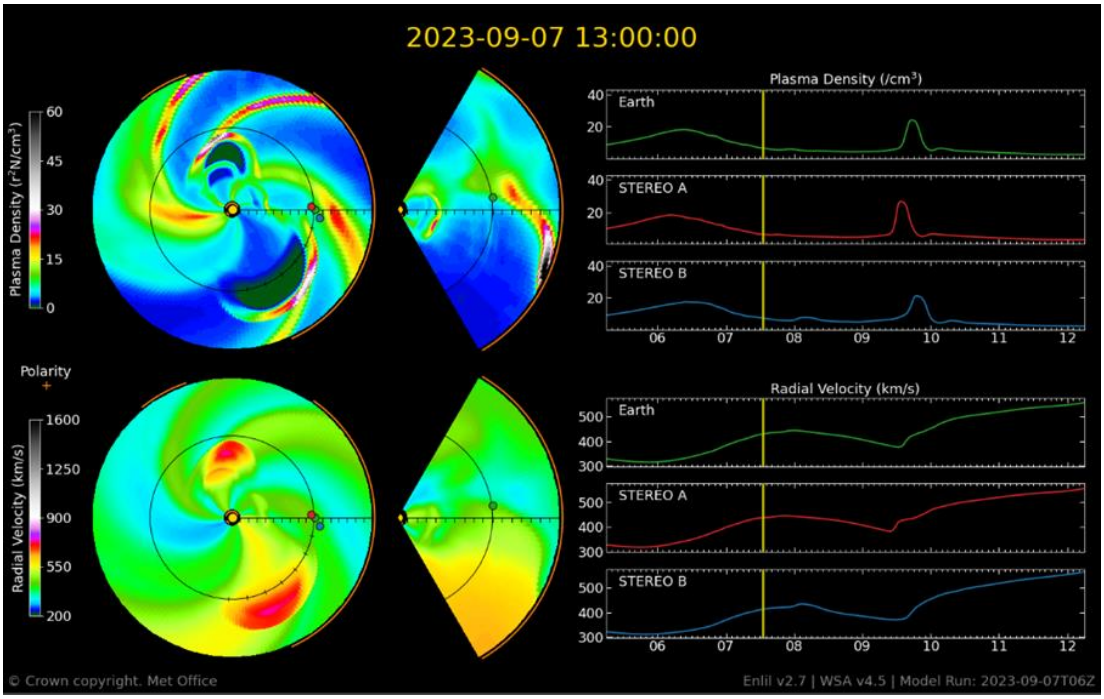
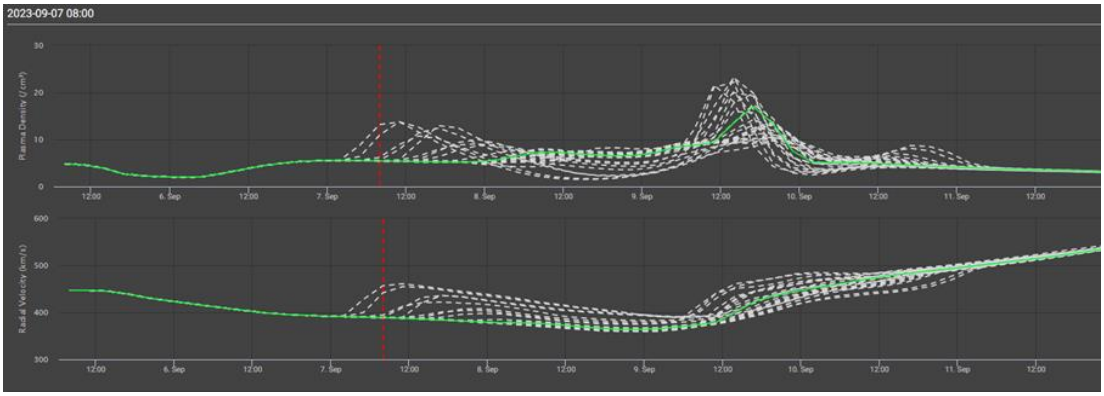
Figure 2: MOSWOC Enlil and ensemble, showing two possible CME glancing blows in the coming days. Enlil is not really modelling any HSSs however, with the possibility of two weak HSSs keeping wind speeds slightly higher than shown here.





Radio Blackouts - X-Ray Flares:

There are currently six sunspot regions on the visible disc. The largest and most complex region remains AR3421. It is rather elongated and consists of a large amount of small spots, currently proliferating, and a rather large single one of opposite polarity. There was a hint of a delta spot for a time but it has now faded away. AR3423, in the east, continues to grow with the emergence of an intermediate spot with penumbra. It has also become slightly more complex magnetically. AR3424 and AR3425 have recently emerged over the northeast limb. AR3424 is relatively small but AR3425 is larger and developing, with the emergence of several little spots on its leading edge. The other regions are small and simple.

No significant regions are expected to depart the disc in the period. However, there are signs from far-side soundings as well as persistence that one or more new regions may rotate onto the disc in the coming days. The current growing trend from AR3421 and AR3423 mean that there is a continuing chance of M-flares throughout the period although the probabilities have been slightly lowered to reflect the recent lull in activity.

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X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: X-Ray Flare activity, as observed by GOES-16, showing only C-class flares in the last 24 hours.

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is at background levels, but just very slightly raised, likely due to recent flare activity.

Proton flux is most likely to remain at background levels, but there is a very slight chance of an enhancement should any significant flares occur, with this most likely from AR3421 or AR3423.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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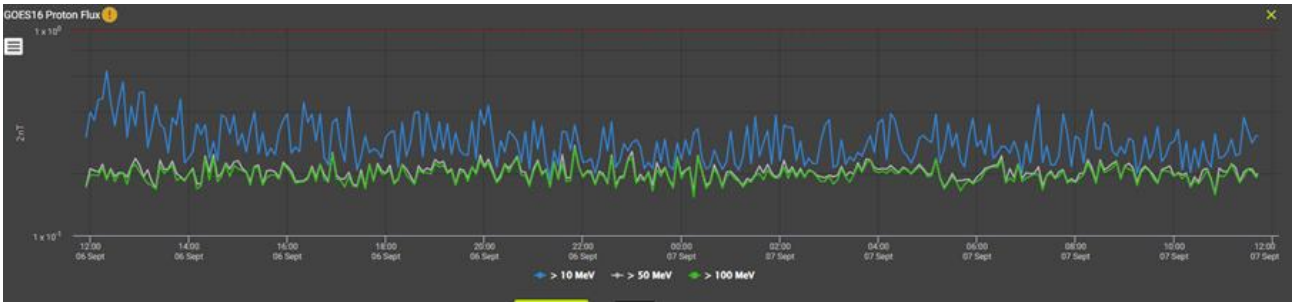
Figure 4: Proton Flux as observed by GOES-16, showing slightly raised levels though well below the S1/Minor Storm threshold.



High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux observed by GOES16 was predominantly at background levels but became moderate for a time, peaking at 831 pfu at 06/1440 UTC. This is likely to remain similar at the start of this period, with further enhancements to the electron belt perhaps occurring through the coming days should fast winds arrive from CH43/- and CH45/-. An increase in flux and fluence levels is therefore possible towards the end of the period. However, there is also the potential for two CME arrivals which may suppress electron levels once again.

The associated 24-hour fluence will most likely remain below the Active (1e8 integrated pfu) threshold throughout the period, but with greatly decreasing confidence with time. MOSWOC REFM is considered to be giving good guidance initially, however, confidence falls through the period given the possible arrival of weak CMEs.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	10	10	20	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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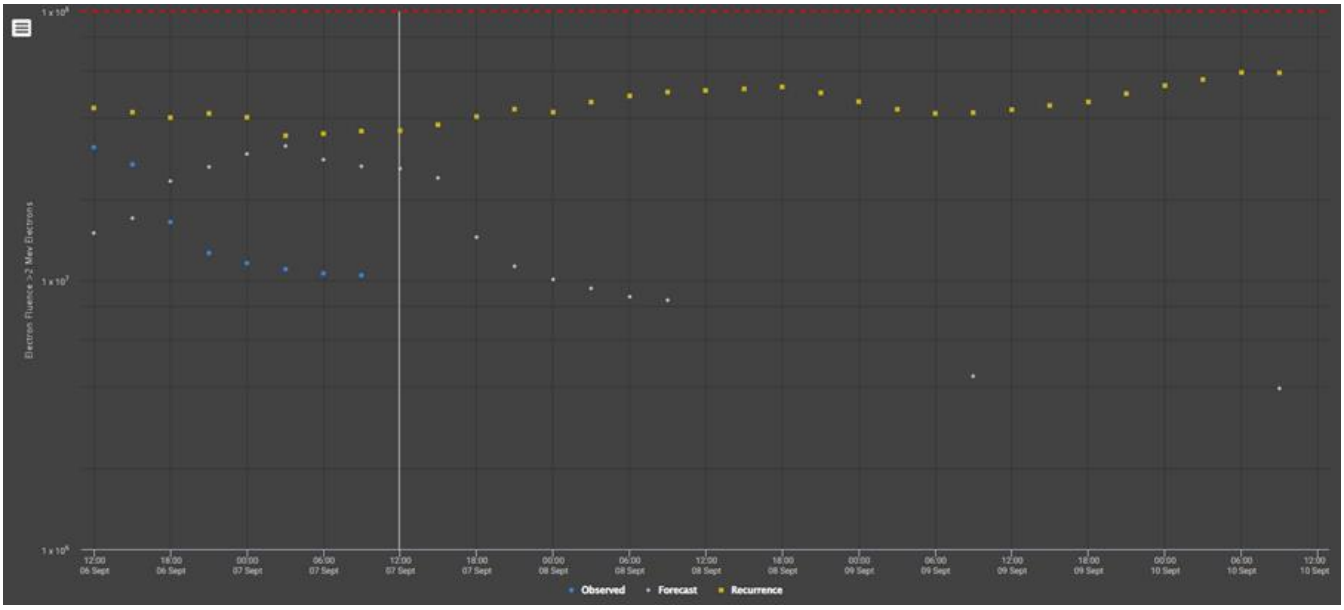
Figure 5: MOSWOC REFM showing a below Active forecast in the coming days.



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